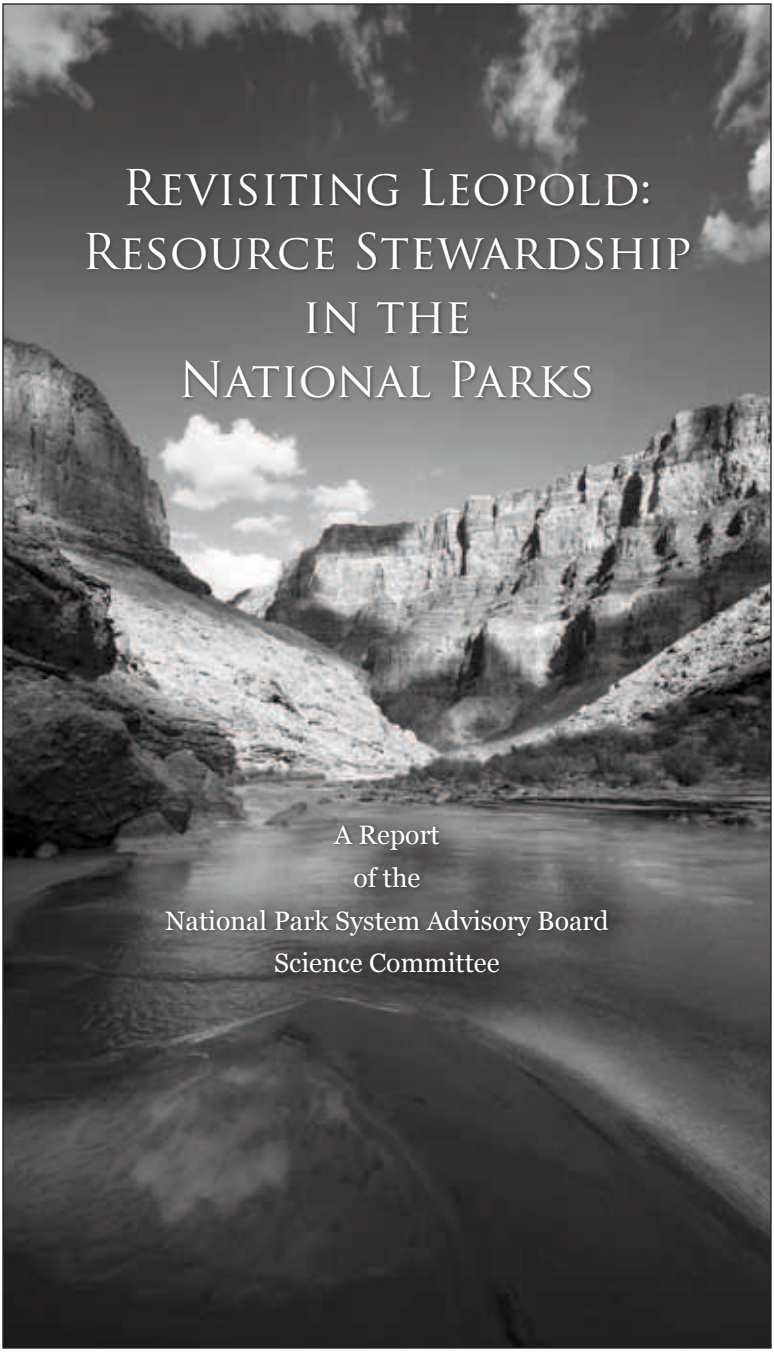

Revisiting Leopold: Resource Stewardship in the National Parks

A Report
of the
National Park System Advisory Board
Science Committee

COVER: GRAND CANYON NATIONAL PARK / ALICIA BURTNER. ILLUSTRATIONS BY ROB WOOD / WOOD RONSAVILLE HARLIN, INC.

National Park System Advisory Board

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August 25, 2012

Director Jonathan Jarvis
National Park Service
1849 C Street NW
Washington, DC 20240

Dear Director Jarvis,

On behalf of the National Park System Advisory Board and its Science Committee, we present to you a report entitled *Revisiting Leopold: Resource Stewardship in the National Parks.*

The *Leopold Report* (officially *Wildlife Management in the National Parks*) was published in 1963. Its influence upon the philosophy, policies, and persons of the National Park Service has far exceeded that of numerous other studies, commission reports, advisory documents, and other attempts to guide and direct the NPS. Much has changed since 1963, and your charge to the present-day Science Committee to revisit the *Leopold Report* was an ambitious challenge. Specifically, you tasked the Science Committee with answering three critical questions: What should be the goals of resource management in the National Park System? What policies for resource management are necessary to achieve these goals? What actions are required to implement these policies? And while the *Leopold Report* focused on wildlife management, you charged the Science Committee with enlarging the scope of concern to include all natural and cultural resources for which the National Park Service has, as the current report notes, “an enduring responsibility.”

Committee members met in several national parks and in Washington, DC. They consulted experts and familiarized

themselves with a wide range of documents, background papers, scientific studies, and other materials relevant to the task. The final report has the full endorsement of all members of the Science Committee and the NPS Advisory Board.

The report strives to provide general and conceptual answers to the questions posed to the Committee. Given the broad topic of park resources and the variety of situations facing National Park Service managers, general principles and guidance are emphasized rather than specific solutions to technical problems of resource management. The suggestions in *Revisiting Leopold* are intended to advance park stewardship during a time of unrelenting change. Committee members feel there is both opportunity and urgency in their recommendations. We hope you find this report useful, as the National Park Service approaches its 2016 Centennial year.

Sincerely,

Tony Knowles
Chair, National Park System Advisory Board

Dr. Rita Colwell
Science Committee Chair
Member, National Park System Advisory Board

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DENALI NATIONAL PARK AND PRESERVE / TREY SIMMONS

Prologue

It is an early summer morning in a western national park. A stream runs alongside a campground, cascading toward the old historic hotel. The campground is full and relatively quiet; the hotel is stirring as the staff prepares for breakfast service. Upstream, elk and deer graze on grasses, while a few early-rising visitors have stopped their cars to eagerly watch and photograph the wildlife. On the higher slopes, alpine flowers—columbine, Indian paintbrush, mountain bluebells—are in bloom, and pikas dart among them. Tent campers who had hiked up from the valley the day before are making coffee on small camp stoves. Higher above, a bighorn sheep stands alert on rock above the boundary of bare ground and the snow-covered slope. Still higher, a small glacier and its annual snowpack reflect the rising summer light. The scene stands as a portrait of a national park at a single moment in time.

But there is another window through which this scene can be viewed, one fitted with the lens of science. Monitoring stations show that the soil is warming earlier in the season. High temperatures and several years of low rainfall have caused the now widespread non-native grasses to dry into fire fuels more rapidly than in previous years. Wildlife studies document an elk herd increasing in number and exceeding estimates of what the valley can sustain. Surveys show early season visitation to the park at an all-time high due to changes in school calendars and an increased population of seniors. Educational programs on local history (based on new research) are attended by enthusiastic tourists. Field botanists have documented alpine flowers blooming days earlier than previously recorded, a trend that began over a decade ago. Ecologists note the pika population moving several hundred feet higher in elevation in response to increased summer temperatures. Glacial ice is declining, exposing new moraine. The scene shifts from just a moment in time or "portrait" to a moving record of a dynamic and continuously changing system. And it is one we do not yet fully understand.

Introduction

The national parks of the United States stand as a singular achievement of the nation. From the establishment of Yellowstone as the first national park in 1872, the National Park System has grown to include 397 national parks, historical sites, urban recreation areas, national monuments, wild and scenic rivers, and national trails, with more than 279 million visits each year. The character and importance of this precious heritage lies at the heart of the American experience, and stewardship of the national parks is an enduring responsibility shared by all Americans.

The extraordinary natural and cultural resources of the National Park System are the environmental, cultural, legal, political, and moral basis of the commitment of the American people to their national parks. The distinctive qualities and features of these resources are the ultimate source of public engagement with the National Park Service (NPS), and their protection, conservation, and restoration are essential elements of the NPS mission. This is not just the technical task of resource "management." The national parks require an ethic of stewardship that focuses on passing the parks unimpaired to future generations. As a result, *park stewardship* is a preeminent duty of the NPS.

This enduring responsibility has been examined previously. In 1963, the *Leopold Report* (officially titled *Wildlife Management in the National Parks*) was submitted to then Secretary of the Interior Stewart Udall by an advisory board of scientists chaired

by conservationist, author, and scientist A. Starker Leopold, son of ecologist Aldo Leopold. The report reviewed the management of wildlife in the national parks as practiced in the 1960s and proposed major recommendations. Since that time, the influence of the *Leopold Report*'s findings upon the philosophy, policies, and professionals of the National Park Service has proved lasting and significant.

Yet new knowledge and emerging conditions—including accelerating environmental change, a growing and more diverse population of Americans, and extraordinary advances in science—make it urgent to re-examine and if necessary revise the general principles of resource management and stewardship in the national parks as described in the *Leopold Report*. The current committee has endeavored to meet this challenge by providing the following conclusions and recommendations.

New conditions, new needs

Environmental changes confronting the National Park System are widespread, complex, accelerating, and volatile. These include biodiversity loss, climate change, habitat fragmentation, land use change, groundwater removal, invasive species, overdevelopment,

and air, noise, and light pollution. All of these changes impact park resources, from soil microbes to mountain lions and from historic objects to historic landscapes. Parks once isolated in a rural or wildland context are now surrounded by human development. Increasing pressures on public lands—from recreational use to energy development—amplify the importance of protected public lands and waters, creating challenges far more complex than in the Leopold era.

Cultural and socioeconomic changes confronting the National Park Service are difficult to overstate. These include an increasingly diversified, urbanized, and aging population, a transforming US economy, and constrained public funding for parks. The National Park System is significantly different—in scope, number of units, size, and complexity—than in the 1960s when the *Leopold Report* was released. Additions to the system include significant cultural, recreational, and urban resources. The cultural values and interests held by the American people have greatly broadened, generating pressing demands for diversity in the National Park Service and for relevancy of the National Park System to new generations of citizens.

Simultaneously, scientific understanding of natural and cultural resources has dramatically expanded, continues to grow at an accelerating pace, and is becoming more quantitative and technologically sophisticated. The conservation sciences have exponentially extended their theories, methods, and findings since the *Leopold Report* was issued (tellingly, the term "biodiversity"

had not yet been coined when Leopold's advisory board prepared its report). Systematic surveys of major organismic groups—not only for vertebrate wildlife but for plants, insects, fungi, and microbes—have expanded on both national and international fronts. Ecosystem management has matured into a science-based activity. There are new realizations of the profound risks human activities pose to oceans and the critical need to protect marine resources. Understanding of system complexity and interrelatedness has advanced along with recognition that this understanding is incomplete. The need for science—to understand how park ecosystems function, monitor impacts of change (even from afar), inform decision makers and their decisions, and enrich public appreciation of park values—has never been greater. In addition, the National Park System is an extraordinary national asset for advancing science and scholarship—from new discoveries of valuable genetic resources to monitoring benchmarks for environmental change and increasing knowledge of the impact of thousands of years of human history on the American landscape.

For all these reasons, revisiting the *Leopold Report*—which requires reexamining the core purposes of the National Park System and the stewardship responsibilities of the National Park Service—is both necessary and compelling as the NPS approaches 2016, the year of its centennial celebration.

The scope of this report

The 1963 *Leopold Report* addressed three basic questions:

1) What should be the goals of wildlife management in the national parks?
2) What general policies of management are best adapted to achieve the pre-determined goals?
3) What are some of the methods suitable for on-the-ground implementation of policies?

Leopold and his advisory board confronted the question of goals boldly and directly, recommending that "biotic associations within each park be maintained or where necessary recreated as nearly as possible in the condition that prevailed" before the arrival of Europeans on the continent. In a memorable phrase, the report declared, "A national park should present a vignette of primitive America." The authors also described implications of this goal as "not done easily nor can it be done completely." The report was adamant:

> *"Yet, if the goal cannot be fully achieved it can be approached. A reasonable illusion of primitive America could be recreated, using the utmost in skill, judgment, and ecologic sensitivity. This in our opinion should be the objective of every national park and monument."*

The current committee has responded to the charge given to it by the NPS and its National Park System Advisory Board—to revisit the *Leopold Report*—by answering three contemporary and expanded questions framed as in the original report:

1) What should be the goals of resource management in the National Park System?
2) What policies for resource management are necessary to achieve these goals?
3) What actions are required to implement these policies?

The current committee elected neither to offer an extended critique of the original *Leopold Report* nor to restrict its recommendations to the central topic that drew Leopold and his colleagues' attention—wildlife management. The committee has neither accepted all of Leopold's conclusions nor rejected them out of hand, and several of the *Leopold Report* findings remain valid and significant. These include:

- The need for the NPS to "recognize the enormous complexity of ecologic communities and the diversity of management procedures required to preserve them."
- The necessity that management "may involve active manipulation of the plant and animal communities, or protection from modification or external influences."
- The high importance of science to stewardship, such that the *Leopold Report* urged "the expansion of the research activity in the Service to prepare for future management and restoration programs."

Several key findings serve as the foundation of the current committee's recommendations. This report focuses on natural and cultural resource management for the units of the National Park System. Many if not most parks include both natural and cultural resources, and many park resources feature natural and cultural attributes—Yellowstone bison are both ecologically important and culturally significant. Parks exist as coupled natural-human systems. Natural and cultural resource management must occur simultaneously and, in general, interdependently. Such resource management when practiced holistically embodies the basis of sound park stewardship. Artificial division of the National Park System into "natural parks" and "cultural parks" is ineffective and a detriment to successful resource management.

While individual parks can be considered distinct units, they are—regardless of size—embedded in larger regional and continental landscapes influenced by adjacent land and water uses and regional cultures. Connectivity across these broader land- and seascapes is essential for system resilience over time to support animal movements, gene flow, and response to cycles of natural disturbance. Migration of aerial, terrestrial, and marine species like the wood thrush, pronghorn, and leatherback turtle routinely transcend park and even national boundaries. Resource stewardship requires land- and seascape strategies and tactics at larger regional scales. The same principle applies for cultural phenomena: scientific testing of drinking vessels from Chaco Canyon indicates the Chacoans drank chocolate beverages made with beans imported from Mesoamerica, linking Chaco

with civilizations to the south. Cultural history transcends park boundaries. Large-scale stewardship means that collaborations, partnerships, and networks are and will continue to be critical to preserve and protect resources.

In contemporary and future resource management, the functional qualities of biodiversity, evolutionary potential, and system resilience matter as much as observable features of iconic species and grand land- and seascapes. Iconic species (from wolves to whales) and grand land- and seascapes (from coral reefs to mountains) depend on the much more difficult to observe but essential characteristics and processes of healthy ecosystems, from decomposition by microorganisms to fixation and flow of nitrogen. Similarly, cultural resources extend beyond iconic buildings, historic sites, and landscapes to include indigenous values, sense of place, historical meaning, diverse forms of cultural knowledge, and the recent past.

Consequently, broad disciplinary and interdisciplinary scientific knowledge and scholarship are necessary to manage for change while confronting uncertainty. New and emerging scientific disciplines—including conservation biology, global change science, and genomics—along with new technological tools like high-resolution remote sensing can provide significant information for constructing contemporary tactics for NPS stewardship. This knowledge is essential to a National Park Service that is science-informed at all organizational levels and able to respond with

contemporary strategies for resource management and ultimately park stewardship.

In addition, the American people—including but not limited to visitors and residents of communities near parks—must be recruited as "co-stewards" of the national parks. The public must be made aware of the challenges facing the National Park System and urged and empowered to take action to preserve and protect these resources as part of their enduring responsibility as citizens.

What should be the goals of resource management in the National Park System?

The overarching goal of NPS resource management should be *to steward NPS resources for continuous change that is not yet fully understood, in order to preserve ecological integrity and cultural and historical authenticity, provide visitors with transformative experiences, and form the core of a national conservation land- and seascape.*

Continuous change is not merely constant or seasonal change; it is also the unrelenting and dynamic nature of the changes facing park systems expressed as extreme, volatile swings in conditions

(such as unexpected, severe wet seasons) within long-term trends of change (such as decadal droughts). Variations in environmental conditions, including extreme events like catastrophic wildland fires, hurricanes, and droughts increasingly exceed historic experiences. Significant uncertainty exists regarding responses of park ecosystems and historical resources to these conditions. It is an essential finding of this committee that given the dynamic and complex nature of this change, the manager and decision maker must rely on science for guidance in understanding novel conditions, threats, and risks to parks now and in the future.

Ecological integrity describes the quality of ecosystems that are largely self-sustaining and self-regulating. Such ecosystems may possess complete food webs, a full complement of native animal and plant species maintaining their populations, and naturally functioning ecological processes such as predation, nutrient cycling, disturbance and recovery, succession, and energy flow.

Cultural and historical authenticity describes the capacity of a historical object or setting to be an accurate representation of a specific cultural time and place, revealing meaning and relevance of the object to its "parent" culture or context, and displaying a genuine and realistic connection to factual historical events. Authenticity—of material objects or intangible heritage like traditional harvesting practices—is multidimensional and rarely absolute. Some attributes of authenticity might be intact (such as the materials in a historic building) while other attributes may

have been substantially altered (such as the functional use of the building or its community context).

Transformative experiences held by visitors to parks are of many kinds, and are based on interaction with natural and cultural resources. This interaction should both educate *and* inspire. Such experiences can be a weeklong, confidence-building wilderness adventure, a first encounter with a night sky free of artificial light, exploring a tidal pool with a park interpreter, or the emotional and patriotic response to standing on a historic battlefield or in an early Native American dwelling. A first, tentative nature walk for the city-raised child may prove as memorable as an exuberant hike by a seasoned park visitor. Distinctive and transformative experiences should be available to all Americans in all units of the National Park System. This requires expanding the relevance and benefits of parks to underrepresented minority groups and communities.

A coherent and sustainable *national conservation land- and seascape* recognizes that 21st-century conservation challenges require an expansion in the spatial, temporal, and social scales of resource stewardship. A comprehensive national conservation land- and seascape includes working lands and waters (for forestry, agriculture, and fishing), recreation areas, historical sites, wilderness areas, wild and scenic rivers, and marine protected areas. Connecting isolated and individual conservation sites into a network adds to their individual and collective resilience over time. The National Park System contains many of the land- and

seascapes most capable of sustaining ecological integrity and cultural and historical authenticity. It can and must be both core and essential to a larger national vision, with the national parks and historic sites serving as permanent anchors of conservation in a continuum of uses.

The contemporary strategies proposed by this committee (with their focus on coupled human-natural systems and connectivity across the larger land- and seascapes) require NPS resource management to embrace a holistic vision and design. This vision emphasizes the role of parks as spatially fixed, largely intact areas embedded in a matrix of adjacent lands and waters where use will change dynamically over time. The NPS should assume its responsibility for "life cycle stewardship" (the goal of managing resources such that species' full life cycles are sustainable over time) and collaborative resource management, whether resources are migratory species moving transiently within parks (such as spawning salmon in Olympic National Park) or co-managed sites important to indigenous communities and tribes (such as Chesapeake Bay or Devils Tower National Monument).

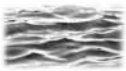
Confronted with continuous and dynamic change and the goal of preserving ecological integrity, NPS management strategies must be expanded to encompass a geographic scope beyond park boundaries to larger landscapes and to consider longer time horizons. Specific tactics include improving the representation of unique ecosystem types within the National Park System, prioritizing the protection of habitats that may serve as climate

refugia, ensuring the maintenance of critical migration and dispersal corridors, and strengthening the resilience of park ecosystems.

The National Park System should become the core element of a national (and with international collaboration, continental and oceanic) network of lands and waters proposed above. Where terrestrial and aquatic protected areas share borders, such as Point Reyes National Seashore and the Gulf of the Farallones Marine Sanctuary, or Olympic National Park and the Olympic Coast National Marine Sanctuary, unique opportunities exist to embrace this holistic vision across ecologically connected boundaries. This network should be managed for resiliency and connectivity, guided by scientific research, and responsible for life cycle stewardship, thereby fulfilling a conservation imperative of protecting the distinctive role and future of the National Park System within the broader American landscape and consciousness.

Because ecological and cultural systems are complex, continuously changing and not fully understood, NPS managers and decision makers will need to embrace more fully *the precautionary principle* as an operating guide. Its standard is conservative in allowing actions and activities that may heighten impairment of park resources and consistent in avoiding actions and activities that may irreversibly impact park resources and systems. The precautionary principle requires that stewardship decisions reflect science-informed prudence and restraint. This principle should be integrated into NPS decision making at all levels.

Contemporary understanding of environmental history and diverse American cultures has enriched our appreciation for the interaction between human and natural systems. The NPS should embrace continued traditional and sustainable use of natural and cultural resources by indigenous communities and tribes, within the broader goal of preserving ecological integrity and cultural authenticity.



What policies for resource management are necessary to achieve these goals?

The NPS should make as its central resource policy the stewardship of park resources to preserve ecological integrity and cultural and historical authenticity, provide transformative visitor experiences, and manage the National Park System as the core of a national conservation network of connected lands and waters. This policy should formally embrace the need to manage for change, the precautionary principle, and to the maximum extent possible, maintain or increase current restrictions on impairment of park resources.

The NPS and its stakeholders are uniquely positioned to propose specific revisions of technical policies for the organization. These

policies should define ecological integrity and cultural and historical authenticity and guide park stewardship over time. Such policies should clearly distinguish appropriate management actions and activities that preserve these qualities from those that can degrade or eliminate ecological integrity and/or cultural and historical authenticity. This will require concerted examination by NPS professionals and stakeholders, as well as the relevant scientific, legal, and policy analyses.

The NPS needs a specific and explicit policy for park stewardship and decision making based on *best available sound science*, *accurate fidelity to the law*, and *long-term public interest*. Best available sound science is relevant to the issue, delivered at the appropriate time in the decision-making process, up-to-date and rigorous in method, mindful of limitations, peer-reviewed, and delivered in ways that allow managers to apply its findings. Accurate fidelity to the law means that the NPS decision-making process must adhere with precision to law, be mindful of legislative intent, and consistently and transparently follow public policy and regulations. Long-term public interest emerges from the NPS mission, the expert judgment of park professionals, and an evolving understanding of public wants and needs. The key is "long-term," which is a necessary consequence of the NPS mission and reflects—at minimum—concern for multiple future generations in time.

While increased scientific capacity is an essential asset of a 21st-century National Park Service, scientific research findings

must be delivered to resource managers and decision makers in the form of usable knowledge. The NPS will require a broad technology innovation policy that encourages adoption of new technologies and establishes coherent strategies for data sharing and access that can be deployed in support of science, resource management, and park stewardship. Existing policies and procedures must be improved to encourage participation of external scientists, scholars, and students in scientific and scholarly research conducted in national parks, and expand the appropriate use of parks as national laboratories for science.

What actions are required to implement these policies?

The NPS should undertake a major, systematic, and comprehensive review of its policies, despite the risk and uncertainty that this effort may entail. The committee emphasizes that it is not recommending revision of the Organic Act, altering the mission of the NPS, or relaxation of restrictions on impairment of park resources. Rather, this review should explicitly focus on aligning policies with the goals for resource management recommended here, and streamlining, clarifying, and improving consistency

and coherence to provide guidance in resource management and decision making.

To implement the resource management goals and policies described in this report, the NPS will need to significantly expand the role of science in the agency. The committee has several recommendations. The NPS must materially invest in scientific capacity building by hiring a new and diverse cohort of scientists, adequately supporting their research, and applying the results. The NPS should train, equip, retain, and support the career advancement of these research scientists and scholars. They should be stationed in parks to provide place-based expertise and knowledge, long-term institutional memory, and technical support for resource management. NPS scientists (and the agency) would greatly benefit from strengthened and supportive supervision, increased opportunities to interact with the scientific community, including professional associations, and specific responsibility and opportunity for publishing their work in the scientific literature. Both NPS managers and scientists require training and requisite skills in communication, critical thinking, analysis, science, technology, and mathematics. The NPS should integrate scientific achievement into its evaluation and performance reward systems, providing incentives for scientists and managers who contribute to the advancement of science and stewardship within their park or region.

This expanded scientific capacity must be interdisciplinary as well as disciplinary, and leverage scientific partnerships with

academic institutions, other federal agencies, and both non-profit and private sectors. It should include well-established sciences such as wildlife ecology, botany, and anthropology. It should also incorporate the newer and increasingly relevant sciences such as genomics and climate change science, and innovative areas of research such as ecological economics, spatial modeling, and related methods.

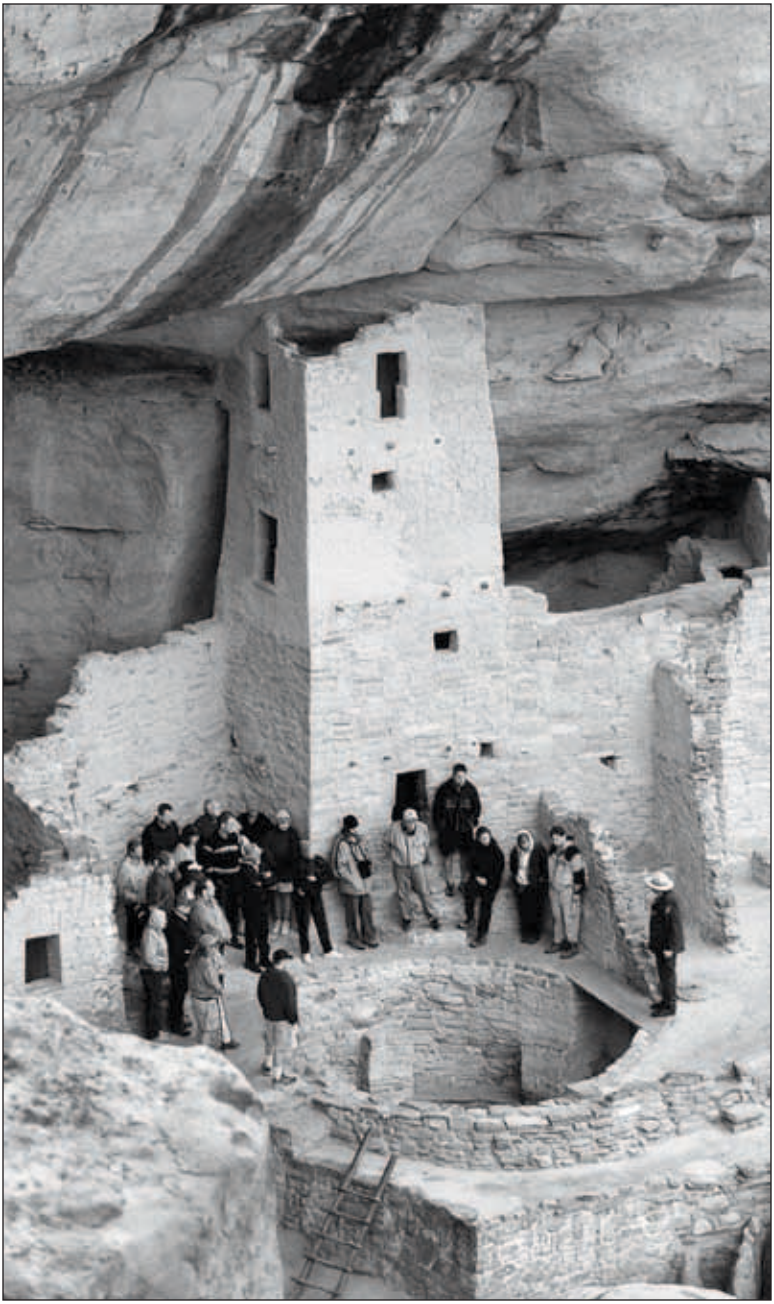
The NPS should establish a standing Science Advisory Board that includes representatives from a range of disciplines within the scientific community. The board would offer external perspectives on science in the parks, provide advice and guidance on science policy, priorities and controversies, and advocate on behalf of science within the agency. The board should be given specific responsibilities and appropriate resources in order to operate effectively.

Investing in science is essential, but it is only one element in preparing NPS stewardship for the future. The NPS must also expand its capacity to manage natural and cultural resources efficiently across large-scale landscapes, avoiding unnecessary bureaucracy while engaging networks, collaborations with academic institutions and other federal agencies (notably the U.S. Geological Survey), and partnerships with states, tribes, and the private sector.

An expanded role for monitoring is an essential component of managing for change. The NPS should function as a scientific

leader in documenting and monitoring the conditions of park systems, including inventories of biodiversity and cultural resources. Monitoring represents an important opportunity to engage the American public (particularly youth) in stewardship of park resources through outreach programs and emerging technologies that support citizen science. The NPS should also lead the way in establishing baseline environmental quality standards and benchmarks of ecological integrity and cultural and historical authenticity. It should invest in and apply analytic and decision-support tools systemwide. The agency should increase understanding of the natural and cultural resources under its care, improve linkages between its substantial current monitoring effort and research needs, and increase access to monitoring data by resource managers and the scientific community.

The NPS has an excellent corps of resource managers, but these managers must be supported with the necessary funds and personnel, as well as with training and professional development. NPS professionals, and especially park superintendents, should be required to possess and maintain significant scientific literacy that extends to an understanding of the strengths and limitations of scientific findings, appropriate application of scientific research to management and policy, and familiarity with key scientific concepts in both biophysical and sociocultural disciplines.



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Conclusion: Opportunity and urgency

Resource stewardship in the National Park Service owes a debt to Leopold's Advisory Board for the cogent principles, philosophy, and recommendations provided in its 1963 report. Now, almost 50 years later, revisiting the key questions raised by Leopold and his colleagues must be done in the context of a new century.

Resource stewardship within the National Park System of the future must be accomplished while addressing development pressures, pollution impacts, climate change, terrestrial and marine biodiversity loss, habitat fragmentation, and the loss of cultural resources. These challenges will only accelerate and intensify in the future. Future resource management based on historically successful practices cannot be assumed as effective park stewardship. Neither is crisis management a sufficient response. Structural changes and long-term investment are necessary to preserve the natural and cultural resources of the National Park System.

There is great urgency in the recommendations put forward in this report—accompanied with an exhortation to the NPS to act immediately, boldly, and decisively. The 2016 Centennial of the National Park Service offers an extraordinary opportunity for action and provides a critical benchmark for progress in meeting this enduring responsibility.

National Park System Advisory Board Science Committee

Dr. Rita Colwell *(Committee Chair)*
Distinguished University Professor, University of Maryland College Park and Johns Hopkins University Bloomberg School of Public Health; Chairman and President, CosmosID, Inc., College Park, MD

Dr. Susan Avery
President and Director, Woods Hole Oceanographic Institution, Woods Hole, MA

Dr. Joel Berger
John J. Craighead Chair and Professor, Wildlife Biology Program, University of Montana, Missoula, MT; Senior Scientist, North American Program, Wildlife Conservation Society, Bronx, NY

Dr. Gary E. Davis
USNPS, Ret., President and Founder, GEDavis and Associates, Westlake Village, CA

Dr. Healy Hamilton
Senior Research Fellow, Marine Conservation Institute, Fairfax, CA

Dr. Thomas Lovejoy
University Professor, Environmental Science and Policy, George Mason University; Biodiversity Chair, The Heinz Center for Science, Economics and the Environment, Washington, DC

Dr. Shirley Malcom
Head, Directorate for Education and Human Resources Programs of the American Association for the Advancement of Science, Washington, DC

Dr. Ann McMullen
Curator and Head of Collections Research and Documentation, National Museum of the American Indian, Smithsonian Institution, Washington, DC

Dr. Michael Novacek
Senior Vice President, Provost of Science, Curator at the American Museum of Natural History, New York, NY

Sir Richard J. Roberts, Ph.D
1993 Nobel Laureate in Physiology or Medicine, Chief Scientific Officer, New England Biolabs, Ipswich, MA

Dr. Richard Tapia
University Professor, Director of the Center for Excellence and Equity in Education; Director of Alliances for Graduate Education and the Professoriate, Maxfield and Oshman Professor in Engineering, Rice University, Houston, TX

Dr. Gary Machlis (*Liaison to the Committee)* Science Advisor to the Director, National Park Service, Washington, DC

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